

Mercer Caverns became the first cave weather station in northern California when the National Speleological Society recorded atmospheric conditions underground. (Harold T. Treacy)

ARTHUR LANGE

## CAVES: New Science Frontier of the West

THE STUDY of caves and of the life and features which they contain is, as a science, new to the Pacific Coast. *Speleology* (the science of caves), as this study is called, represents a composite of sciences, embracing in particular their underground implications, and applying these to the problems which caves present. Thus speleology is made up of such studies as those of underground drainage, climate, biological communities, prehistoric remains, formation of sediments, crystals, and the record of ancient man — to name but a few of its components. Yet at the same time it should not be construed as an arbitrarily defined activity whose sphere of attention is bounded by the wall of daylight at the cave entrance; for the study of underground phenomena is of little significance if it cannot be related to the features and events of

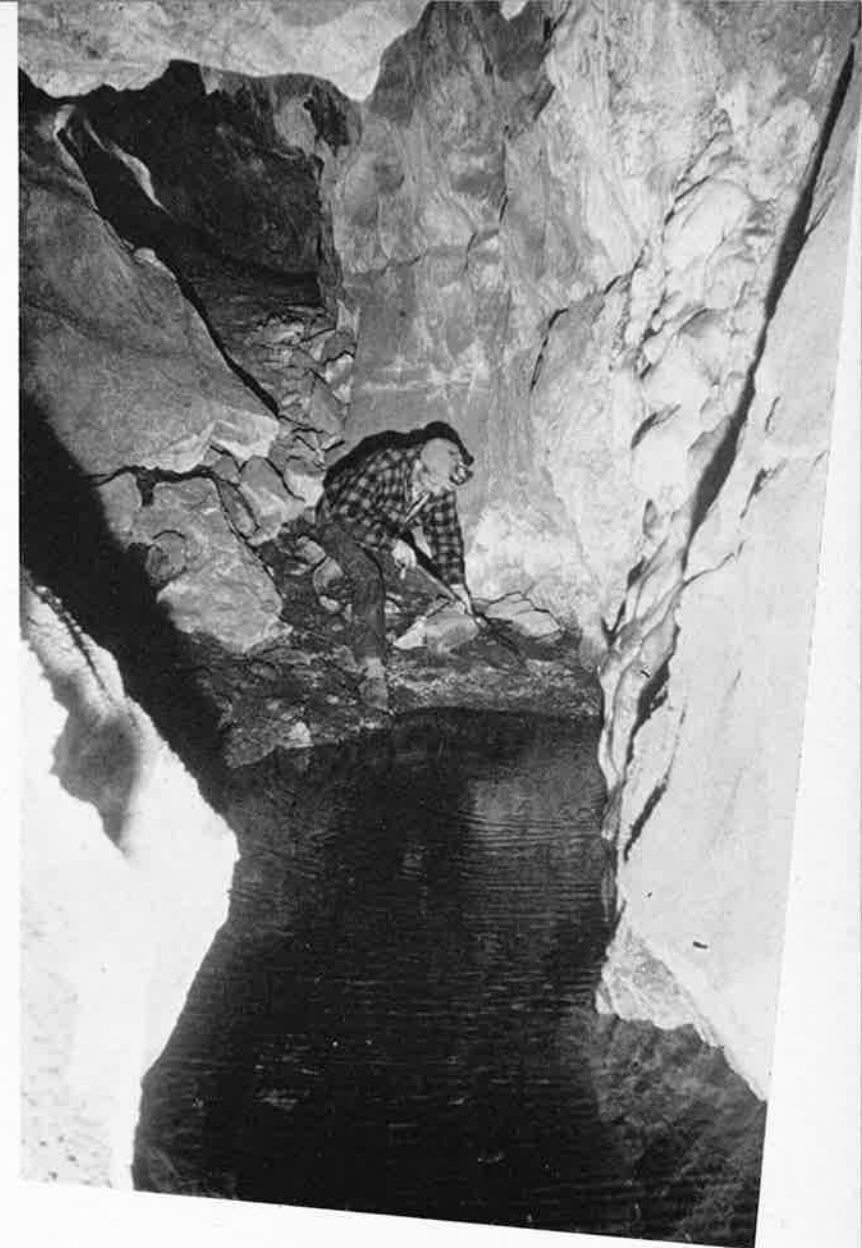
the surface. For example, the landscape of limestone terrain, known as *Karst topography* (after a limestone plateau in Yugoslavia), is a direct expression of its underlying caverns; the disappearances of streams are clues to the enigma of underground drainage; the life of the sheltered interior reflects perhaps inhospitable circumstances of the outdoors; and the traces of man and animals encountered underground represent a unique sampling of a former population of the earth. It is the recognizing of this "two-storied" meaning of caves that tells the difference between the cave-explorer and the serious speleologist.

### To save our caves

The Western Speleological Institute is a research group devoted to the study and preservation of natural caves, and as such, it has conducted several

Investigating a pool in the Cave of the Catacombs, Calaveras County, California. (Edward Danchy)

field expeditions, including a survey of the caves of California and Nevada. In their operations they find, however, that the actual study of the caves proves to be the easier half of their objective; it is rather the protecting of the caves from the "careful hand and careless foot" of inconsiderate visitors and deliberate vandals that is their most difficult problem. Alongside the soot-blackened, scribbled-on, chopped-up walls and stalactites of the majority of our caves, the carved trunks of aspen trees of the forest are but an oversight; alongside their broken-down, sawed-off stalagmites and pilfered crystals, one can hardly lament the stumps of great trees which have seen service: for trees heal their wounds and forests regrow, within a lifetime. Cave destruction, on the other hand, is not a temporary ill; it means the extinction of the cave as a thing of beauty and a studio of science for countless generations in the future. Untold are the numbers of examples of these grim displays encountered in our Western caves, and still unforeseen is a broadly effective solution to the problem. The things of beauty and discovery that remain, however, are more than rewarding enough to supply the drive to preserve them. Do not the elegance and significance of the crystalline drapery illustrated justify any measures — no matter how stringent — necessary to preserve them? Yet these are but two aspects of many such phenomena,



which are becoming lost to our view as the roads of man penetrate continually farther into the wilderness. Let us consider in greater detail the role that caves and their features play in our world of knowledge and appreciation, so that we may more carefully evaluate their significance and the argument for their protection.

### Sea caves and lava tubes

Not all of our Western caves, though many are large, are the underground universes that make up Carlsbad and Cacahuamilpa, and only a few are known to contain the weird, eyeless fish and blind amphibians such as characterize Marvel and Mammoth caves. Our caverns are nevertheless intriguing and enlightening, from the standpoint of their geologic origin and structure as well as for

their many exceptional deposits of fossil remains.

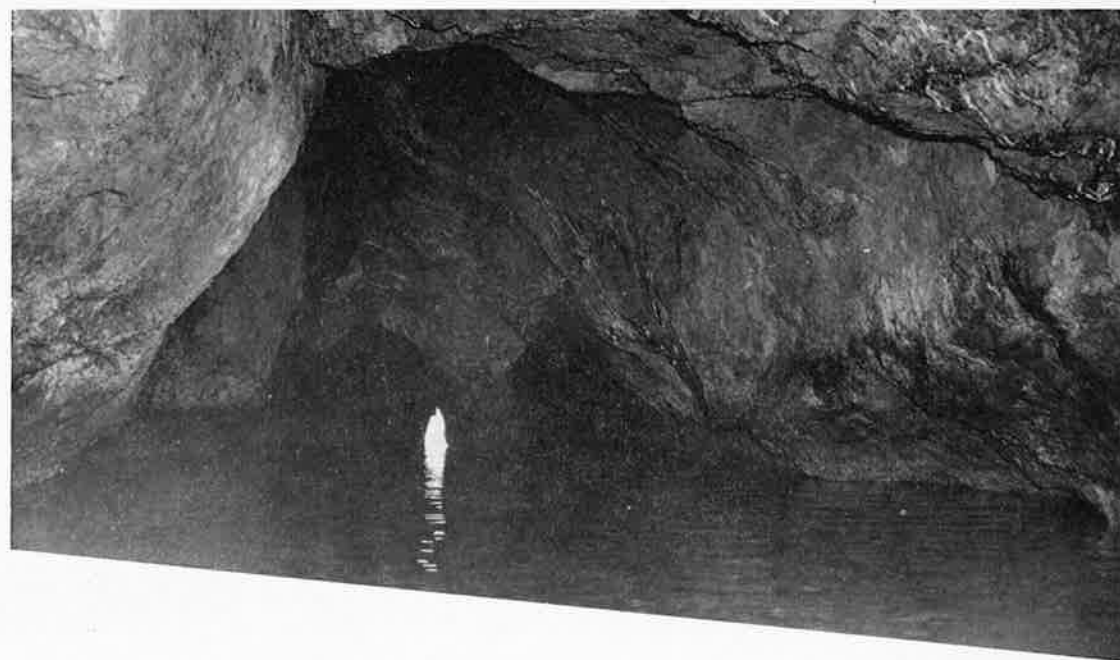
In California alone we encounter a rare diversity of forms: marine caverns, sandstone dens, rock shelters, lava tubes, not to mention a generous representation of elaborate limestone caves. All of these, with the exception of the lava tubes, have their origin in a plane of weakness—a joint or fracture — in the country rock in which they are housed, the initial infection gradually spreading so as to produce eventually a sizeable cavity or cave. In limestone the process is carried out by the solution of the rock walls by water charged with natural carbonic acid; in granite, by the fracture and avalanche of cliff faces and large rock masses; in sandstone, through erosion and abrasion by rain and windblown sand; and in the fault-riven faces of the rugged Pacific coast sea

cliffs, by the incessant poundings of the broadside waves and the rhythmic compression of the surge.

These last-mentioned caves, especially those of the Channel Islands off the southern California coast, comprise what is probably our finest exhibition of the development of caves from planes of weakness, for every one of the countless ominous openings and geyserlike blowholes displays a prominent fault or joint extending down the face of the volcanic escarpment and on through the underlying cavern, into which a prevailing swell is constantly retreating. With favorable seas it is

core of molten material. If in seeking a downhill course this material succeeds in locating an outlet of escape, either at the foot or sides of the flow, it leaves in the form of a cast the elongated hollow tunnel that we call today a lava tube. Its single unbranching passage is generally of uniform diameter throughout its extent, and is fringed with the hardened stalactitic drippings which bear evidence of the rapid disgorging of lava that once took place. Such tubes are often of great length — John Muir describes Pluto's Cave in northern California as penetrating its basalt bed for a mile.

Sponge Cave,  
a marine cavern  
on Santa Cruz  
Island.



possible to navigate the dark, echoing labyrinths within, some of which have been explored to a measured depth of 450 feet. Of all the sea caves of the islands, beautifully variegated Painted Cave of Santa Cruz Island is probably the most renowned. Its navigable extent is reported to exceed a quarter mile.

The one exception to the fracture origin of caves occurs in the case of lava tubes, which are found generously distributed throughout the extensive lava beds of northern California and Oregon. Their formation is, rather, attributed to a differential cooling of the molten material or magma comprising a volcanic flow at the time of eruption. The upper and lower strata of the fluid mass, being subjected to the relatively cool temperatures of the air and ground solidify first, abandoning to the contours of the underlying topography an interior

Some tend to accumulate a permanent deposit of ice which contributes to the ornamentation of the cave. These so-called "ice-caves" are still but little understood.

#### Limestone caves

Natural limestone caves are the type most familiar to the layman and, as might be expected, most interesting to the speleologist. They occur in many forms and lengths — ranging from the narrow Indian burial shafts of the Mother Lode region, to the intricate subterranean systems of multileveled chambers and corridors underlying the limestone lenses of the Sierra Nevada. But in no case are these systems randomly designed, for their patterns reflect the inherent structure of the containing rock mass, with its configuration of planes of weakness, variation of chemical composition, and relation to the drainage of the region.



The entrance  
to Cueva Valdez,  
Santa Cruz I.

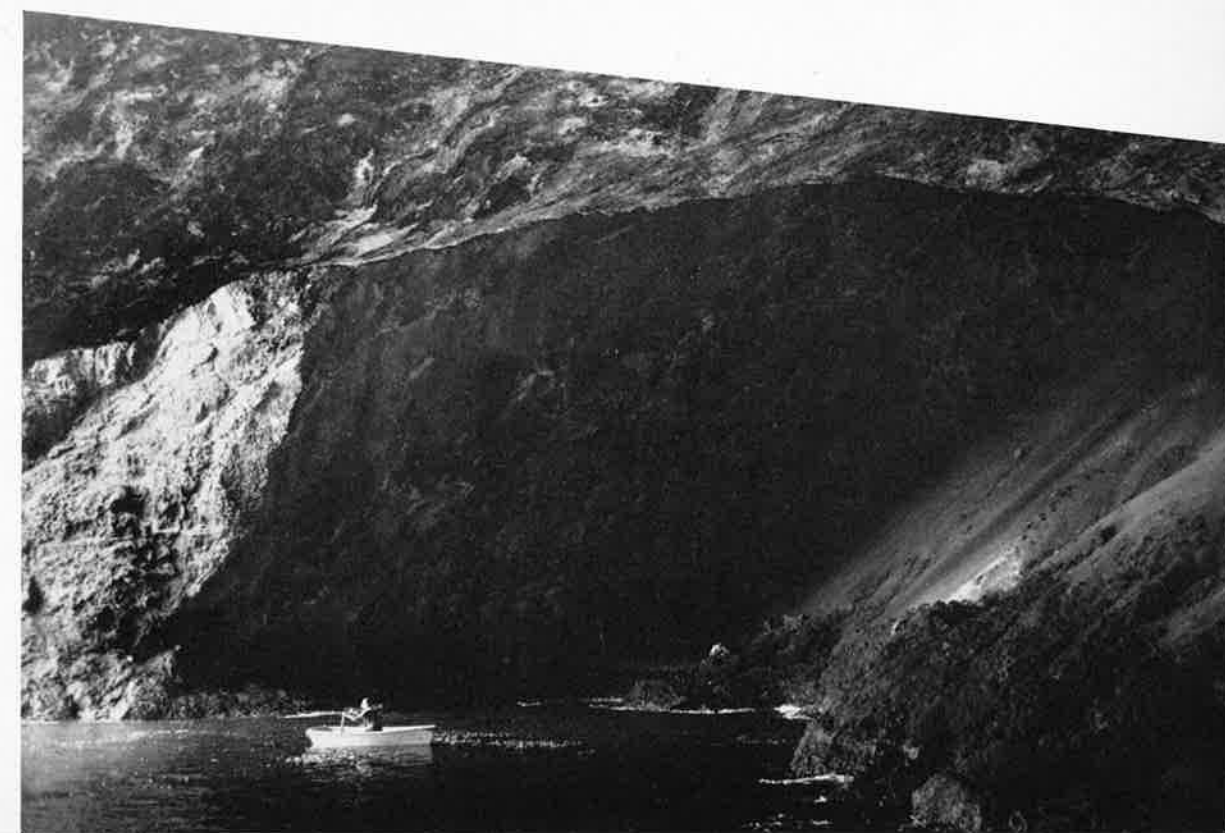
Since solution of the rock can take place only where the acidular waters can penetrate, namely along the fractures, it is those along which the cave chambers and passages evolve, the maximum development following along the circuit of most intense flow. The flow, being controlled by the upland and overlying topography and the general elevation of the surface above the level which the drainage is seeking, will effect a cavern-system expressing these under-and-over relationships as they prevail at the time of formation. In this way, a modern cave records by its structure the story of the landscape which overlay it during the geologic episode in which it lay in the path of its generating waters. But this is only part of the fascinating history.

#### Underground glaciation

When the dissolving waters finally abandon their channels and galleries for still lower routes

beneath the cave, air invades the emptied chambers and residual surface water trickles in through cracks in the ceiling and walls, setting a new mechanism ticking — the precipitation of crystalline calcite. Stalactites grow downward from the ceiling, and their overflow gives rise to stalagmites on the floor. Flowstone forms where sheets of water pour along the slopes. Dense colonies of pretzel-like helictites sprout from any niche where moss might grow, were there sunlight to feed it. These and many more crystalline growths, called *speleothems*, come to populate the chambers with the statuary and jewelry which makes them so priceless. And deep down in the microscopic growth rings of these curious structures we find still another record — that of the variations in the supply of moisture and humidity of the chamber throughout their development. Though they are an almost inscrutable calendar to read today, there will come

Yates Cave on  
Anacapa Island  
was formed by the  
ocean's surge,  
which disintegrated  
the rock along the  
fault that can be  
traced across the  
ceiling in the photo-  
graph. (Walter S.  
Chamberlin  
photos)







▲ Calcite assumes many different forms and figures when it is deposited in the limestone caves. Here it occurs in the form of radiating crystals. (George Mowat)

➤ A helictite cluster with stalactites growing downward from it. (Edward Danehy)



a time when man's understanding of their processes will allow their translation; meanwhile, every shattered stalactite is a potential record lost.

There are still other episodes of earth's history to be learned from within. The caves of the southern Sierra Nevada provide an excellent example of the effect of glaciation underground. After the final uplift of the range, when Mt. Whitney and its company attained their 14,000-foot heights, glaciation enshrouded the crest in alternating ice-cloaks, between which sun and rain collaborated in washing down-mountain the cobbles, gravels, and powdered fragments which the ice dismembered from the peaks. Since many of our canyon caves lay in the path of these great floods, they became invaded by torrents of water and sediments, their galleries and corridors becoming filled and blocked by glacial debris. With the return of mild climates to the region the run-off abated and, within the caves, slowly dripping waters proceeded to deposit crystals of calcite, stalagmites, and flowstone over these sediments, sealing them in place and rendering them invulnerable to successive invasions of glacial run-off.

There thus remain today in our mountain caves cemented gravels and sands derived from perhaps all four known glacial advances of the Sierra, and within these deposits are found entrapped the crystallized bones and skeletons of mammals. If man was present during these events, he too may be represented in the cavern glacial record. No finer inscription of the glacial history of the range

Stalactites, stalagmites, and columns are formed through the precipitation of calcium carbonate by dripping water. Man's arm gives scale. (George Mowat)

can be asked, than that record of these sequestered chambers, where neither rain nor frost nor wind disturbs the treasured evidence.

#### An "underground roller-coaster"

These records and many more have been encountered in the desert ranges of Nevada as well as the boreal country of the Sierra. Great subterranean conduits have been explored, through which water once coursed under high pressure from uplands to valleys, filling the passageways to their ceilings with their torrential flow, traveling in places up steep grades, or undulating in the manner of a gigantic siphon. Model Cave, in eastern Nevada, might be described as an underground roller-coaster, being essentially a single tube nearly two thousand feet in length, along whose course, both on the crests of the rises and in the intervening troughs, are encountered the layers of sand, gravel, and boulders, brought in by the flow and attesting to its torrential volume in times past. Similar systems, called *pressure channels*, may be functioning today deep within the hollow heart of each limestone range, but we can hardly hope to gain access to them, before uplift and dissection of the present landscape allow their contents to drain.

#### Earth's fever chart

The knowledge to be gained from underground reconnaissance, however, is not limited to geologic phenomena. One finds below a suggestion of a history of our outdoor climate, in the record of temperatures of the cave walls and atmosphere. For it is known that the heat of the sun, reaching the surface of the land, in time succeeds in pene-



trating deep into the interior of the rock, in a manner characteristic of the *surface* fluctuations of temperature. These surface fluctuations constitute the *thermal history* of the region, and the dips and rises of this temperature record correspond on one scale to our annual seasons or day-to-day variations, while in the long-range view they represent glacial advances and interglacial episodes. All of these time-variations of past temperature of the surface are preserved today in the depth-variations of the rock walls of the caves, the relationship between the two being mathematically calculable, in a way that may allow us to read the prehistoric climatic changes which controlled the

Helictites have defied the researches and study of mineralogists for many years. (Edward Danehy)

migrations and behavior of man and animal. Experimental observations conducted in the two caves thus far examined reveal the presence of the previous winter's cold during the summer, as prescribed by the laws of heat flow.

#### Dwellers of the dark

The environment in which life occurs is often found reflected in the peculiar characteristics and adaptations of its inhabitants. From such considerations one might expect to meet, in the damp and dripping atmosphere, constant temperature, and eternal darkness of caverns, extraordinary forms of life. This is certainly the case as demonstrated in the tortuous labyrinths of Cave City Cave in California's Mother Lode — a cave once called one of the great wonders and curiosities of the West.

Here among its maze of chambers and corridors and deep, placid pools thrives an industrious pop-

Range species. Snails, earthworms, and small mammals — rodents for the most part — complement the cave population, while special forms of fungi and algae represent the plant kingdom. Of all these denizens of the dark, however, the ubiquitous bats are undoubtedly the most familiar, and few indeed are the caves in which they cannot be found commuting to and from their secret retreats in the deepest recesses. But it must be remembered that many of these life forms are found in but one or only a handful of caves, and within them but in small colonies; being rare, they need protection from the threats of cave destruction and excessive collecting.

#### Treasure-chest of fossils

Besides serving as residences for living biological forms, certain — in fact many — Western caves have assumed the role of protective depository for important fossil remains of prehistoric mammals. Near the shores of man-made Shasta Lake in northern California is situated Potter Creek Cave, not a large one as caves go, but one which has received more scientific attention, so far, than any other California cave. At the time of its discovery in 1878, there were found in its one large chamber called the Golgotha the fossilized bones of the rare Pleistocene short-nosed bear, *Arctotherium*. Then again in 1902 the cave was visited, this time by an organized expedition of paleontologists from the University of California under the direction of W. J. Sinclair, and at that time the floor of the Golgotha was systematically excavated, almost to the point of being turned inside out. Altogether between four and five thousand determinable specimens were disinterred, comprising 52 separate specimens of mammals, of which 21 proved to be extinct forms, and seven, new species. Included were the remains of Pleistocene sloth, horse, camel, bison, and elephant. In the words of Dr. John C. Merriam: "The remains . . . furnish the most satisfactory representation of the Quaternary fauna of California that has yet been obtained in one locality." Besides Potter Creek Cave, there occur many similar "golgothas" in the West, some of which have already yielded valuable deposits, and more that are still awaiting discovery and excavation. Those that are known, however, are in serious need of effective protection from pilfering and trampling, in order that they may remain in their undisturbed state until the time and means are available for their study.



Twenty-one extinct species of mammals were found in Potter Creek Cave in 1902 — seven of them were new to science. The search for new forms still goes on. (George W. Moore)

ulation of flies, spiders, millipeds, and amphibians isolated from the illuminated world. Studies of these specimens have revealed a number of them to be forms new to science, or types far beyond their normal outdoor range; among them, spiders and insects which have lost their pigmentation and faculty of sight, frogs which have temporarily changed their coloration to a ghostly gray-white, in the manner of a chameleon, and the first salamander collected in a California cave — a Coast



Upper Natural Bridge, Calaveras County, California. (Doug Kirkland)

#### Caves and man

If the records of prehistoric animal life yielded by our Western museum-caves arouse wonderment, the discoveries relating to early man currently being made in caverns of Nevada and the Mother Lode should excite the curiosity of all who witness them. And it is actually possible to observe these archeological excavations in Moaning Cave, Calaveras County, California, which is open to visitors. Here, buried in the stalagmitic floor of the massive and inspiring Main Chamber, 170 feet beneath the surface, has been revealed an amazing aggregation of ancient Indian skeletons and artifacts — the mute remains and accoutrements of dead believed long ago consigned to this immense communal tomb. In 1950 the California Archaeological Survey carried out the preliminary excavation of the upper strata of these deposits and ascribed the skeletal material to the Middle Horizon (1500 B.C. to 500 A.D.) Miwok Indians, who then inhabited the Sierra foothills. Subsequently, suspecting that still older material might be encountered at greater depth, archeologist Phil C. Orr of the Santa Barbara Museum of Natural History, with the aid of geophysicist O. H. Truman, penetrated 15 feet down into the calcite encrusted mass of skulls and bones before meeting an apparent bottom layer. Studies of the minute laminae of the

flowstone crusts have placed the minimum dates for the accumulation of these remains between 12,500 and, just possibly, 50,000 years ago.

Such records of early man — as these in Moaning Cave — and the records of more recent Indians found throughout our vast Southwest, are, of all the valuable features exhibited by caves, the most vulnerable to vandalism. Time and again an archeologist will pack up his tools at the close of a season, returning to the site the following year, or even week, to find it but a disheveled trash pile of bones, dirt, and discarded artifacts, all trace of sequence and relation having been obliterated in the greedy rummaging of irresponsible persons seeking trophies. The speleologist and archeologist together are striving desperately to preserve our caves and sites from such destruction, not only until the time that present-day means allow their study, but beyond — in order that future scientists with far more refined tools of examination may possess material to study, and that future inhabitants of our West may inherit something still of natural beauty. To insure these commitments both of today and of the future all possible help and coöperation are needed on the part of scientists whose work sometimes invades the province of the cave, and on the part of citizens who hold an interest in the phenomena of nature and an appreciation of her art.

